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THE

OPHTHALMIC REVIEW

A MONTHLY RECORD OF OPHTHALMIC SCIENCE

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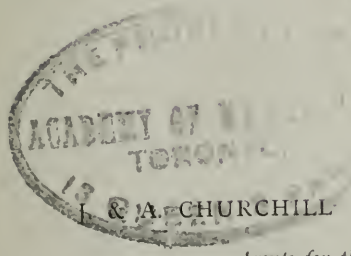

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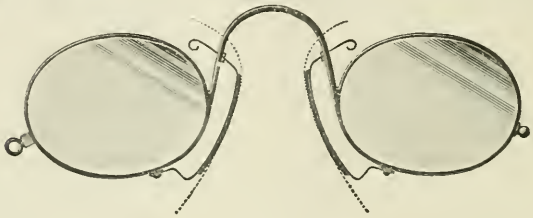

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THE INNERVATION OF THE OCULOMOTOR MUSCLES.[1]

By George A. Berry, Edinburgh.

It is not by any means easy to give a satisfactory explanation of the state of innervation of the oculomotor muscles corresponding to all the different positions which the eyes may assume in binocular or uniocular fixation. The problem in general is perhaps mainly one of physiological interest. There are, however, some points which are of not a little practical importance. A correct appreciation of them cannot fail to influence our diagnosis and treatment of certain abnormal conditions of ocular motility. And yet, that even the more evident relations of innervation are not generally borne in mind is shown by the constantly repeated use of such terms as: *muscular squint*, *secondary contracture*, *insufficiency of internal or external recti*, &c. With regard to the first, of these—muscular squint—the term arose from the idea which originated in Germany that the cause of a squint was to be referred to some structural alteration in the shortened muscle of the deviating eye. Notwithstanding that it is more than twenty years now since Hansen-Grut exposed in the most conclusive manner the untenability of such a view, it is still adhered to by not a few. The so-called *innervation theory* of Hansen-Grut has, however, at last received many supporters, and is

[1] Read at the Annual Meeting of the British Medical Association, Newcastle, 1893.

now, one might almost say generally, recognised to be the safest guide in practice. I have on different occasions referred to the host of easily demonstrated facts which go to support this theory, and to show that only by means of an abnormal degree or an abnormal deficiency of convergent innervation, *equally* distributed over the two eyes, is it possible to explain the existence of a truly concomitant squint. I do not, therefore, propose to discuss this point here.

The term, *secondary contracture*, as indicating the supposed condition of the antagonist to a paralysed ocular muscle, is another of the German fallacies which has been very generally accepted without any question in this and other countries. Now, I would ask, in what way does the so-called secondary contracture resemble an undoubted contracture of any of the skeletal muscles? In contracture of these muscles the position assumed by the limb or head, as the case may be, is, so long as the contracture lasts, as immovable as if that position had been voluntarily assumed. The antagonistic muscles are unable to overcome the *spasm* of the contracted fibres. In the case, however, of "secondary contracture," after paresis of an ocular muscle, whilst it is of course evident from the position of the eye that there is a greater shortening of the antagonist than of the paretic muscle, it is equally evident that the antagonist is not in a state of spasm. This is apparent from the fact that in most cases there is no absolute hindrance to movement in the direction opposed to that of the action of the shortened muscle. A person who has, for instance, convergent strabismus from paresis of an external rectus, has, nevertheless, the power of directing the deviating eye outwards, to an extent which usually brings the axis of vision at least parallel to the mesial plane. Often the degree to which adduction is possible is much greater. Sometimes it is

less, and the eye may indeed be practically immovable in the direction of action of the paralysed muscle. I shall afterwards offer an explanation for this in discussing the nature of the so-called secondary contracture in general. In the meantime I merely wish to point out that the term implies a misconception and ought to be discontinued.

Again, with regard to "insufficiency of the internal recti." The incorrectness of this name for a very common condition is evidenced by the fact that in these cases there is no interference with the power of rotating either eye inwards in association with an outward rotation of the other eye. It is only the power of simultaneous adduction of the two eyes, or of *convergence* which is defective. For this reason, Hansen-Grut long ago suggested the name *insufficiency of convergence* as more correctly indicating the nature of the abnormality. In this he has had not a few followers, amongst others, Landolt. Yet not only is the old expression "insufficiency of the internal recti" still in use, but there is a pretty general absence of appreciation of the real nature of the defect, which would hardly be the case if the proper terms were in general use. Thus, it is not very long since I saw an English ophthalmic surgeon tenotomise an external rectus for insufficiency of convergence unassociated with any marked latent divergence for distance, and prepared to divide the other externus as well, had he not discovered that he had already converted an *imaginary* insufficiency of the internal recti into a *real* insufficiency of one externus, and given his patient homonymous diplopia, for distance. In view of the possibility of such mistakes, we cannot afford to say "What's in a name," &c.

The object of the present communication is to attempt to analyse, by the help of clinical experience, the nature of the innervation processes in the internal and external

recti. The question of the innervation of the other oculomotor muscles is not only more difficult, but is not of the same practical importance.

Let us first consider the following point:—When the two eyes have been converged towards a near point by the simultaneous innervation of the two interni, what is it that, when the fixation of that point is given up, brings them back to parallelism? Is it the cessation of the impulse to convergence alone, or this combined with an impulse to divergence? Is there such a thing at all as a diverging impulse? It is true that inasmuch as an absolute divergence can serve no useful purpose there is no habit which could favour the development of an impulse to divergence starting from parallelism. But this is not equally true of relative divergent movements. There is no *a priori* reason why, starting from convergence, there should not be an impulse to divergence which would tend to restore the position of parallelism. If, on the other hand, such an impulse really did exist, one would expect to find it possible to strengthen it by introducing conditions which made binocular fixation at a distance only possible with a greater and greater degree of absolute divergence. One would expect, inasmuch as fusion would always be the regulating influence, that the use of abducting prisms or other optical means would enable one to increase the diverging power to an extent which was only limited by the degree of possible outward rotation of either eye. This is, however, not the case; there is a much narrower limit to the degree of absolute divergence possible in the interest of binocular vision. It rarely equals and never exceeds that which asserts itself on prolonged exclusion of one eye. That is to say, it is never greater than that amount of divergence which may be found where the necessity for convergent movements is absent, and where such movements have as a consequence been abandoned. This surely points then to an absence of any real diverging impulse.

But it might be supposed that although no impulse ever exists to a simultaneous contraction of the two externi, the change required in the direction of fixation for relative divergence might nevertheless be effected by the active contraction of some other muscles. The two obliques of each eye might possibly do so by acting together. The effect that each muscle would have, both on vertical and torsional deviation, would be then neutralised, and only the diverging effect remain. If this were the case one could understand, too, why only relative and not absolute divergence might be an active process. That under ordinary circumstances the obliques have nothing to do with the mechanism of relative divergence is evident from the fact that paralysis of the superior oblique does not in any way interfere with the process. Again there may be complete inability to move the eye outwards, even from a position of adduction without the co-existence of any paresis of the obliques.

We are driven therefore, as it appears to me, to explain the movements of divergence starting from a convergent position by assuming a relaxation in the impulse to convergence, an impulse as to the reality of which there is no doubt whatever.

What then is the state of innervation of the external recti when the optic axes are converged? Before answering this, let us consider the innervation state of the two antagonistic lateral muscles when the eye is directed straight forwards. As the eye is capable of being easily rotated, there must, in order that it may retain this position, be a balance between the force which would tend to turn it out, and that which would tend to turn it in. This balance would be possible either if both muscles were slack and exerting no tension, or if both tended to contract to an extent which caused an equal rotational strain in opposite directions.

It is obvious, too, that the degree of innervation to contraction in the muscles may vary subject to the one condition that it is equivalent in both muscles. We know, in fact, that such a difference in the innervation of the balancing muscles for the same straightforward direction of one eye does actually exist, for Hering has demonstrated in a way which is probably familiar to us all, that the stimulus to convergence is equally distributed to the two internal recti whatever may be the position of the near object fixed with reference to the mesial plane. If it lies right in front of one eye the axis of that eye is directed exactly as it would be if a distant point in the same line were the object of fixation. But as the internal rectus tends to contract in response to the impulse to convergence which it receives, the externus must undergo a corresponding change in tension through increased innervation in order to prevent the balance being disturbed. The internal rectus of the other eye again receives both the stimulus to contraction due to the converging impulse, and that due to an impulse to associated activity with the opposite external rectus. The proper direction of that eye is therefore the result of a definite and sustained increase in the innervation of the internal rectus alone. There is no call, so far as we can see, for any stimulus to contraction of the externus in connection with the position required by the altered fixation. There must, however, in every position of this eye, as well as in the straightforward direction of the other, be a balance between the force tending to inward and that tending to outward rotation. And if the inward rotating force remains not only constantly active during the fixation of a near object, but is of varying amount according to the distance of that object, it follows that the opposing force must also be a real and varying one.

Hence it cannot be supposed that the external rectus

remains slack during the contraction of the internal. It must therefore either be in a state of contraction before any convergent movement is begun, or must follow suit by contracting simultaneously with, or immediately after, its antagonist. Which of these two possibilities is what actually takes place cannot, perhaps, be determined with certainty. Does the externus, for instance, receive an increasing innervation to contraction while the internus is effecting an inward movement of the eye? Such an innervation, while not leading to any actual shortening of the externus (which on the contrary becomes lengthened) might nevertheless be assumed to act in the way of controlling and steadying the movement of rotation in the opposite direction. This kind of innervation could be accounted for well enough in the case of associated lateral movement of the two eyes, as we should only have to assume the check action of a practically simultaneous innervation to associated movement in the opposite direction, and therefore the action of one of the innervation impulses, of the existence of which there is no doubt. But in the case of convergent movements the same check action could only take place by an impulse to divergence, the existence of which, as we have seen, there is no conclusive evidence for assuming, or by an impulse to associated movement in both directions at the same time. This possibility again seems negatived by the absence of any imperfection in convergent movement in cases where there is a loss of associated movement to one side.

On the other hand, if we suppose that the muscles are always in a state of contraction, at all events during the period of full consciousness, there does not seem to be any reason for assuming any further innervation in the lengthening muscle to control the movement caused by the active contraction of its antagonist. Some resistance there must be under the circumstances, and no

doubt a resistance which increases as the active muscle becomes shorter with the increasing innervation to contraction. But we know that an actively contracted muscle offers resistance to any force which tends to elongate it, and further that it requires a greater force to produce a greater elongation. Within certain limits too, there is found, even in experiments with the ordinary muscle-nerve preparation of the frog, to be a pretty definite correspondence between the degree of elongation and the weight which the muscle has to raise. In the living muscle brought into action by the normal stimulus this correspondence is no doubt still closer. In the case of the ocular muscles it is therefore not unlikely that the regulating influence on the rotation in any direction is provided by the stretching of the contracted antagonist without any change taking place in its state of innervation. As, however, the same degree of resistance may be supposed to correspond always to the same length of the muscle as long as the innervation is the same, the cessation of the stimulus leading to rotation in one direction will at once cause the antagonist to contract, and thus bring about a movement in the opposite direction. The contraction taking place in this way, too, will continue and produce movement in the opposite direction until, on the absence of any more than normal resistance, the normal length of the muscle (corresponding to its state of innervation) has been regained.

There appears, indeed, to be a very intimate relation between the shortening of the one muscle and the elongation of the other. We find, for instance, that the same increase of innervation will produce the same amount of rotation in the two eyes, whatever may have been the previous lengths of the contracting and of the stretched muscle. This is seen in the completeness of the concomitancy which characterises an ordinary squint,

a completeness which, as I have elsewhere stated,[1] I have found by careful measurements to be truly astonishing. Notwithstanding the difference in the initial position of the two eyes, their axes maintain the same angular relation as the eyes are moved from side to side in response to a stimulus which must be assumed to be equally divided between the internus of one side and the externus of the other. Now in convergent squint the innervation of the muscles is the same as for the fixation of a near point. But while, during convergent binocular fixation, lateral movements also take place with perfect concomitance, there is this difference, that it is always possible for these to be regulated by fusion.

Let us represent by means of a diagram[2] what takes place in the associated lateral movements in convergent squint. The axes of the two eyes R and L instead of being parallel in distant fixations converge and meet at some definite point in front. If the right eye be then moved to the left through an angle θ the left will also move in the same direction, and the angular change will (until certain physiological limits have been passed) be so nearly equal to θ, that any difference which may exist is not greater than the error of observation in making an objective measurement. That is to say, that notwithstanding the absence of binocular vision, and notwithstanding the difference in the initial positions of the two eyes, and therefore in the lengths of the two contracting muscles, the stimulus to lateral movement produces an equal amount of contraction in both.

Now let us again diagramatically represent the presumable state of innervation of these two muscles before and after the lateral movement has been carried out. We may put E for the normal amount of innervation to contraction in the externus of either eye when the

[1] Helmholtz, *Festschrift.*

[2] We have not considered it necessary to reproduce the diagrams here as the meaning is sufficiently clear without them.—[*Ed.*]

eye is directed straight forwards, and no accommodative effort made. This we shall say is balanced by an internus innervation, I. The absolute and relative values of E and I are no doubt subject to individual differences, but this need not be taken into account here. As the case is one of convergent squint, each internus receives an additional and equally distributed stimulus to contraction, which we may denote for the sake of simplicity by a number, 2, for instance. So far then the state of innervation of the lateral muscles would be denoted —for each externus E, and for each internus I+2. This innervation would produce an equal degree of inward rotation of both eyes. But we are assuming the case where the one eye, the right, is directed straight forwards. A stimulus of the same amount, 2, must be added to its external rectus innervation, in order that it may balance the action of the internus. But such a stimulus appears only to take place in association with an equal stimulus to the opposite internus. We must, therefore, on the plan adopted, denote the states of innervation as follows :—Right externus E + 2, right internus I + 2, left externus E, left internus, I + 4. This is merely Hering's explanation adapted to convergent squint instead of to near fixation. Movement to the left is now opposed in the left eye by an elongation of the innervated externus, equal in amount to the shortening produced in the internus by four units (or what, for the sake of illustration, we may take as units) of innervation to contraction. In the right eye, again, movement to the left begins against a resistance which, in addition to the initial contraction in each lateral muscle, is made up of the stimulus to shortening of the internus by two units counteracted by the same amount of stimulus to further contraction of the externus. But as an associated impulse to lateral rotation produces equal angular change, it would appear as if these two

resistances were equal in amount. In other words, it looks as if the elongation of the left externus in the state of innervation E produced by the shortening of the antagonist in the state of innervation I + 4, gave rise to the same resistance to further contraction in the left externus as is offered to that of the right internus when, with an innervation I + 2, it is opposed by an externus innervation, E + 2.

These different states of innervation in the several lateral muscles can then be accounted for by the combined action of but two different impulses; the impulse to associated lateral movement and the impulse to convergence. Further, as from what has been said with regard to the reality of the elasticity of the contracted muscle and the equivalence of the strain caused by shortening of the initially contracted muscle and equal elongation of the initially contracted antagonist, we must, I take it, assume that lateral movements are only in part due to active innervation.

If a state of increased innervation of the interni has to be maintained during convergence, to counteract the vital elasticity of the stretched externi, it follows, I think, that the same active innervation to associated lateral movement must be constantly kept up in the corresponding internus and externus to maintain a lateral direction of fixation. It is not easy to see why the elasticity should come into play in the one case and not in the other. If, when for instance, the two eyes are turned to the right, movement to the left were only to take place by means of an active innervation, the impulse would have to be one stronger than that which maintained rotation to the right, as this would first have to be overcome. But an indefinite increase in the amount of impulse which this would entail on each successive change in the direction of fixation cannot be imagined possible.

We must, therefore, account for the movement from right to left at its start at all events, in some other way than by an active increase of innervation in the left externus and right internus. And just as we have assumed that relative divergence takes place by a relaxation of the converging impulse, so we have reason to assume that the first thing to take place in this case is a relaxation in the contraction of the right rotators from a gradual withdrawal of the impulse to associated right rotation. This may be supposed to take place in the case under consideration until the initial state of contraction E, in the right externus has been arrived at, and consequently until the innervation of the left internus equals that of the right, viz., I + 2. After this point, however, instead of a relaxation of the impulse to rotation in one direction must come the active impulse to rotation in the opposite direction. And that this really does occur is evidenced in cases in which the power of associated movement is absent in one direction, though perfectly normal in the other. Here there is no interference with the power of recovery to the middle line after the cessation of the active movement in the direction which is possible. Only in fact in the way just described will, as may easily be seen, the required relations between contraction and elongation be maintained throughout, and, therefore, the concomitancy remain perfect.

When there is a latent divergence or convergence there will be concomitancy in both uniocular and binocular fixation only so long as this is due to defective or excessive innervation to convergence. This is the usual case, and the mechanism by which it is prevented from becoming manifest is by alterations in the strength of the convergent stimulus under the beautifully delicate influence of fusion.

When, however, there is a real preponderance of

one lateral muscle over another, we have, just as in paresis, loss of concomitancy, and the corresponding excess of the secondary over the primary deviation. In fact, such a true preponderance is all but invariably the result of paresis.

I have already referred to the so-called contracture of the antagonist, and given reasons for holding that the term contracture is misleading. What then is the nature of the deviation which is known by that name? It is a true preponderance of the antagonist as indeed it was long ago designated by v. Græfe. This preponderance will be greater or less according to the extent to which what I have called the permanent or initial innervation, (a great part of which is no doubt what is generally called the tone) is influenced by the paresis. It will be latent or manifest, too, according to the power which fusion may have in overcoming it by combined alterations in the stimuli to convergence and associated movement. It is well known that this preponderance does not by any means correspond to the extent of paresis. It may be more marked in a slight paresis than in such a complete paralysis that the affected muscle is unable to carry the eye beyond the middle line.

A DEPARTURE IN THE OPERATION OF CANTHOPLASTY.

By Kenneth Scott, Cairo, Egypt.

The usual classical operation of canthoplasty cannot always be relied on as an unfailing remedy in cases of blepharophimosis or blepharospasm. More particularly is this true in those cases where the condition is an extreme one, or where there is, or has been, a considerable amount of inflammatory action in the eyelids accompanied by thickening, and very often by hypertrophic degeneration of the palpebral conjunctiva. These are the cases in which the operation of canthoplasty is most often called for, and when the one which is usually described has been performed, there is often a slight reactionary œdema, the lips of the wound approximate, and in spite of every preventive effort a reunion of the opposing surfaces occurs. Sometimes, on the other hand, the middle suture, which is placed in the outer angle of the palpebral fissure, tears its way through the conjunctiva, and the eye returns again to the condition it was in before operation.

The following is the manner of procedure which I now invariably employ: The outer canthus is divided with scissors in the usual way; a spring eye-speculum is then introduced between the eyelids, and the portion of conjunctiva which is opposite the centre of the wound is freed by scissors from its attachment over the globe, almost as far as the corneal margin. The free edge of the conjunctival flap, still held in the fixation forceps, is attached by a fine silk suture, as in the usually described operation, to the apex of the skin wound, when it will be found that there is not the slightest tendency towards dragging. The speculum is removed, and the conjunctival edge is then sewn in turn to the opposing cut

margins of the upper and lower eyelids. A silver wire suture, which has been thoroughly softened in the flame of a spirit-lamp, is then passed right through the substance of the upper eyelid, from the skin to its conjunctival surface, near to its ciliary margin, and a short distance from the cut surface of the canthus. It is fastened by twisting lightly, so as to avoid constricting the tissues. The needle-end of the suture is then passed through the substance of the eyebrow, directly over the outer third of the eyelid, and is fastened by twisting it there to the other free end brought up to meet it. The lower, palpebral part of this strand of silver wire is then curved outwards with dissecting forceps, so as to evert the outer end of the new lid-margin, and prevent all possibility of its approximating to the opposing cut edge of the lower eyelid.

I have never known any suppuration or other irritation occur, if the parts have been thoroughly cleansed previously with some efficient antiseptic lotion, and after operation an antiseptic dusting-powder, such as iodoform and boric acid in equal parts, applied.

The silver-wire suture should not be removed until it is seen that the wound between skin and conjunctiva is quite healed; this usually takes place about the fourth day. The operation can be performed with cocaine quite easily, except in the case of children, when a general anæsthetic is usually required.

GREEFF (Frankfort-on-the-Main). Bacteriological Investigations with Reference to the Origin of Sympathetic Ophthalmia. *Archives of Ophthalmology, July*, 1893.

In an interesting paper, Greeff refers to the work of the numerous investigators, who during the last few years have studied the problem of the parasitic nature of sympathetic ophthalmitis. The results obtained by nearly all these workers have been to a greater or less extent contradictory of those published by Deutschmann some eleven years ago. Greeff's experimental results have led him to conclusions very similar to those of Schirmer, Mazza, Randolph, Gifford and others.[1] He believes, from his own investigations and from study of the literature of the subject, that Deutschmann's migration theory cannot be regarded as proven until sympathetic ophthalmitis has been repeatedly produced experimentally by other investigators, and the presence of micro-organisms in the sympathising eye demonstrated, and this without the co-existence of general infection of the animal. Three cases of sympathetic ophthalmitis examined with reference to the presence of micro-organisms, are referred to. Details of the first are as follows :—

The patient was struck in the right eye by a knife on June 16, 1890. When seen by Greeff, there was a perforating wound of cornea with incarceration of iris, wound of lens, and intra-ocular hæmorrhage. June 25th, sluggish iridochoroiditis. Ten months later, sympathetic ophthalmia developed in the left eye. A few days later, resection of the right optic nerve was performed, and a small piece of the nerve removed, under careful aseptic precautions. The following procedure was adopted : (*a*) a portion of optic nerve was put into bouillon. (*b*) A portion was put into glycerine agar-agar, and two attenuations were made from this and poured into saucers and kept at blood-heat. (*c*) A small particle of the nerve was inserted into the anterior

[1] See *Ophthalmic Review*, 1892, p. 298, and 1893, p. 83.

chamber of a rabbit. (*d*) The remainder was put into absolute alcohol. The plate cultures and bouillon remained sterile, and six weeks later the media of the rabbit's eye were clear, and the piece of optic nerve was still visible.

A similar method of examination was adopted in two other cases of sympathetic ophthalmia, and notwithstanding the most careful bacteriological examinations, no micro-organisms were found.

Greeff thinks that Deutschmann's and Wagenmann's experiments justify the conclusion that "micro-organisms were present in eyes which had given rise to sympathetic ophthalmia," although this has not been verified by most investigators. Hence it cannot be regarded as proved that the organisms were the causal agents in those cases of sympathetic disease in which they were found.

It is common knowledge that in many cases a considerable period elapses between the injury and the onset of sympathetic inflammation in the fellow eye. In such cases the writer thinks it is natural to suppose that micro-organisms in the optic nerve of the injured eye would have perished long before the appearance of the disease in the second eye. To decide this question Greeff examined the ends of optic nerves in fourteen cases, in which neurectomy was done in order to avert sympathetic ophthalmitis. The interval between the injury and the resection varied from three weeks to three months. Cultures were made on various culture media, sections were stained and examined, and in not one instance was anything observed which could be said to correspond to what Deutschmann described. No micro-organisms were discovered in the nerve or its sheath. These results are entirely in accord with those of Ohlemann, Randolph and Pflüger. Limbourg and Levy found in several eyes a coccus corresponding to one described by Sattler, but experiments with this organism failed to produce sympathetic ophthalmia, and in the majority of eyes they found no organisms. As Greeff remarks, these facts recall Koch's general rules regarding bacterial infection, viz.:—(1) The organisms ought to be demonstrable in all cases of the disease, and it is self-

evident that an organism cannot be the specific one if the disease can occur without it. (2) The organism should be found in this disease and in no other. (3) The organism should be present in the tissues in such numbers and under such conditions as to explain the clinical symptoms. (4) It ought to be possible to cultivate such an organism and produce the disease experimentally.

In the further experiments conducted by Greeff, he devoted special attention to one point, namely, whether the organisms wandered into the optic nerve and its sheaths, and whether the same organisms were found elsewhere in the body, *i.e.*, whether general infection of the animal took place. Experiments of this kind, in which general infection occurs, are of no value as evidence in favour of Deutschmann's migration theory. The changes in the second eye may justly be attributed to the presence of organisms throughout the general circulation, and not to the selection of the optic nerve, as the path by which the organisms reach the eye. Experiments on rabbits, in which inoculations are made in other parts of the body often give rise to eye disease. Meyer examined a rabbit which was thought to be suffering from sympathetic ophthalmia produced experimentally. He found, however, that other rabbits in the laboratory exhibited exactly similar changes in the eyes, although in them the inoculations, for a totally different character of experiments, had been made in parts of the body remote from the eye.

In man, sympathetic ophthalmia is never attended with general infection.

The following is a brief report of Greeff's inoculation experiments :—A putrid solution was injected into the vitreous of three rabbits. Panophthalmitis ensued, and perforation of the globe. No changes were visible in the second eye. A few weeks later the inoculated eyeball was removed, and, together with a small portion of the optic nerve, examined for micro-organisms. None were found. If micrococci usually migrated from the eye to the optic nerve and sheaths, retrobulbar abscess would be frequently met with in cases of panophthalmitis.

Aspergillus fumigatus was injected into the vitreous of four rabbits. In two of the rabbits this was followed by slight haziness of the fundus, with tortuosity of the vessels and redness of the papilla, but these appearances were gone in two or three days. Such changes have already been described by Randolph, and thought by him to be due to the inflammatory processes in the inoculated eye, and not to the presence of organisms.

An emulsion of staphylococcus pyogenes aureus was injected into the right eye of seven rabbits, and after a "certain length of time" the end of the right optic nerve, the left eye, and the blood from several of the organs were examined. One rabbit died from meningitis, two wasted away, and four lived. In the first three rabbits inflammatory changes were found in the second eye, and micro-organisms in the end of the (right) optic nerve and in other organs. Of the four rabbits which lived, only one showed slight change in the second eye, but no organisms were found in any of them. These facts failed to prove a direct migration of the organisms along the optic nerve and its sheaths, and it is to be noted that organisms were discovered in the second eye only in those rabbits in which general infection had occurred.

Greeff concludes his article by a short discussion of the theory that sympathetic inflammation may be set up by the metabolic products of organisms in the injured globe, which enter the lymph streams and so reach the fellow eye. This explanation has been offered by Gorecki and Rosenmeyer. The absence of febrile manifestations in sympathetic ophthalmia is, however, adverse to this view.

Greeff does not advance any new hypothesis as to the pathogenesis of the disease. His experiments were undertaken with a view of verifying Deutschmann's work; his results, however, have led him to join the already long list of investigators who have failed to obtain evidence confirmatory of Deutschmann's published experiments. He is still "inclined to believe in the parasitic origin of sympathetic ophthalmia." J. B. L.

MAKLAKOFF (Moscow). Edison's Electric Pen in Ophthalmology. *Archives d'Ophtalmologie, Sept.*, 1893, *p.* 530.

The electric pen invented by Edison consists essentially of a small electro-motor actuating a needle so as to produce a very rapid series of uniform punctures. The needle has an amplitude of movement of about one-third of a millimetre and a rapidity of about 9,000 punctures per minute.

Maklakoff has applied this instrument with certain modifications for clinical purposes.

Tattooing the Cornea.—The needle being adjusted so as to give a penetration of any depth desired, cocaine is used to the eye, and the part to be tattooed is coated with the desired colour. The electric pen used in this way enables the operator to work with remarkable precision and rapidity. The only inconvenience which appears to attend it is the induction of rather free hæmorrhage.

Massage.—With the view of obtaining, in place of the punctures ordinarily produced, a rapidly repeated percussion of the part subjected to its action, the needle was tipped with a minute ivory ball, a small flat plate, &c. By this novel form of massage or tetanisation some remarkable results were obtained. Applied to the ciliary region of the eye it produced partial contraction of the pupil and injection of the small arterial circle of the iris. In normal eyes no other change was observable in the contents of the anterior chamber, but if there were a small amount of blood or pus at the bottom of the chamber this was immediately rendered apparent by its diffusion through the aqueous humour. The agitation produced in the chamber was particularly well seen in presence of fragments of traumatic cataract undergoing solution. These were thrown into rapid movement and displaced from one part of the chamber to another. In view of this observation the author recommends the use of the instrument as a

means of expediting the solution of cataract, and records a case in which he used it with advantage five times, the applications being made every second day and lasting five minutes each time.

Hoping to produce some effect by transmitting the vibrations to the retina and optic nerve, Maklakoff tested the action of his instrument in cases of optic atrophy. In these cases the instrument was not applied directly to the eye, but through a small india-rubber balloon filled with water and laid on the closed eyelids. As regards the optic nerve no discoverable result was obtained, but the proceeding was followed by a remarkable lowering of the tension of the eye. After a tetanisation lasting two minutes a measurement of the tension by means of the author's tonometer showed a change corresponding with a fall of mercury from 27 mm. (the normal pressure) to 9 mm. It was noted, if we understand the author rightly, that the lowering of tension obtained by the first tetanisation soon disappeared, but that when the operation had been several times repeated on successive days the lowered tension became permanent.

In glaucomatous eyes which had been treated by sclerotomy or iridectomy the vibrator usually produced a transient lowering of tension, and after several repetitions a permanent reduction. In one instance the tetaniser was applied to a glaucomatous eye presenting very high tension, and the result was an outbreak of acute glaucoma which was immediately and successfully treated by operation.

The author hopes to obtain some useful results in cases of retinal detachment, but records no observations at present.

In a case of traumatic cataract with hernia of the iris treated by immediate operation the vibrator effected a displacement of the lens matter towards the wound more rapidly than is usually possible by the pressure of the finger or the speculum.

In a case of annular posterior synechia with increased tension, in which neither mydriatis nor myotics availed anything, three applications of the vibrator to the ciliary

region, on three successive days, each application lasting two minutes, broke the adhesions throughout the third of the circle and effected a lowering of the tension which proved permanent three weeks later.

The following five cases also are mentioned as having been markedly benefited by the use of the vibrator, the improvement being in each case associated with a lowering of tension: parenchymatous iritis with posterior synechia and slight hypopyon; hæmorrhagic irido-cyclitis with hypopyon and severe pain; cyclitis with deposits on the posterior surface of the cornea; diffuse parenchymatous keratitis; suppurative keratitis.

In the author's opinion the rapid succession of minute blows produced by the instrument, strongly influences the processes of intra-ocular nutrition, driving the fluids through the outlets and lymph spaces even when these channels are obstructed by morbid changes.

While applying the vibrator to the eye of an exceptionally docile patient, Maklakoff took the opportunity of examining the fundus with the ophthalmoscope, and noted that venous pulsation was induced more readily than by strong finger pressure.

Treatment of Trachoma.—On attaching the needle of the electric pen to the blade of a small knife, or fixing a small cutting edge on the instrument itself, Maklakoff found that in cases of trachoma he could scarify the granulations with great rapidity and very little pain. P. S.

GALTIER (Nimes). The Brown-Séquard Treatment of Grey Atrophy of the Optic Nerves. *Annales d'Oculistique, May*, 1893.

The author expresses his surprise that in the numerous communications made by Brown-Séquard of the good effect of the injection of organic fluids in locomotor ataxy, no mention has been made of the adoption of this treatment in cases of optic nerve atrophy, a condition which is

often merely an early symptom of ataxy, or, less frequently, of other diseases of the spinal cord. He gives notes of a case under his own care, which, though incomplete, seems worthy of attention.

M. B., male, aged 35, first seen on December 13, 1892. Primary syphilis in 1880. In 1888 he suffered from shooting pains in the thorax and limbs, and paretic genito-urinary symptoms; dilatation and immobility of pupils were noticed by his medical attendant. In February, 1892, his sight failed considerably, and three months later he was under active treatment by mercury and iodide of potassium. Slight improvement took place, but was followed by further deterioration of vision. When he came under Galtier's care, the patient complained of great general weakness, lightning pains, and great defect of sight. The knee-jerks were absent; the pupils widely dilated; Argyll-Robertson phenomenon marked. The left eye counted fingers at 20 to 30 centimetres, in a small portion of the field of vision at upper and inner part. Colour sense abolished. The optic papilla was pale, with a bluish tinge; the central vessels abnormally slender. The right eye retained vision of $\frac{1}{10}$; the field of vision was concentrically contracted; the field for blue and red more contracted; light red and green were not recognised. The papilla was pale, bluish in colour, not excavated; the vessels little, if at all, shrunken.

The patient was again put upon mercury and iodide of potassium, but this was stopped in a few days in consequence of iodism, &c.

On December 27th, hypodermic injections of organic fluid were begun. The fluid employed was obtained from the testicles of the bull and ram, and the injection was made in the back, and the dose was at first one cubic centimetre. From December 27 to January 12, this quantity was injected daily; from January 13 to 26, the dose was doubled. At this latter date there was no appreciable improvement in sight, but the patient's general condition was decidedly better. The injections were now omitted for one week, but resumed on February 3, and continued

in two cubic centimetre doses till the 19th. After this, three cubic centimetres were injected. On February 4th, vision (in the better eye) was $\frac{1}{8}$, and colour vision had slightly improved; February 19, vision was $\frac{1}{8}$ easily; March 6th, vision was $\frac{1}{6}$, and this acuity was maintained but not surpassed. The general condition of the patient was greatly improved; the lightning pains had disappeared.

Although an increase in visual acuity from $\frac{1}{10}$ to $\frac{1}{6}$ is not very great, Galtier thinks that, considering the extremely serious nature of the affection, such a result is noteworthy. This case is the first in which he has seen definite improvement in vision from any treatment, in the optic atrophy of spinal cord disease. J. B. L.

WARD A. HOLDEN (New York). On the Development and Extension of Orbital Sarcoma. *Archives of Ophthal.*, *xxii.*, 3.

The author has recently examined three specimens of recurrent sarcoma of the orbit, more especially with a view to determining their exact manner of extension. The cases had all different starting points; thus one sprang from the periosteum, and was mainly fibrous; another grew from the cellular tissue of the orbit, consisting almost exclusively of small cells, while the third arose from the choroid and spread backwards along the optic nerve, forming foci in the dural sheath of the nerve and in different parts of the orbit. In each case the cells of the most recently developed portions of the tumour, as also the sarcomatous cells in the infiltrated tissues and in the foci at a distance from the main growth could, as a rule, be traced to the proliferation of the adventitial or endothelial cells of vessels continuous with those of the mass of the tumour.

Case I.—Mary D., aged 12, first seen May 1, 1892. For nine months previously the left eye had at intervals been much swollen. No history of injury. Protrusion of left globe to the extent of 7 mm. Marked limitation of mobility. There is a hard, insensitive growth, about 6 mm. in diameter, adhering to the inferior orbital wall, and extending backwards into the orbit.

May 16. Tumour excised; it was found to reach back to the sphenoidal fissure and was adherent to the periosteum and the external rectus. It was tough, firmly encapsuled and measured 15 by 4 mm. The growth was examined by Dr. W. M. Gray, who reported as follows: "Miliary tuberculosis. The specimen is composed of bands of dense fibrous connective tissue. Between the fibrous bands is a dense lymphoid infiltrate, while throughout the tissue are numerous aggregations of these cells forming nearly typical miliary tubercles. These cell aggregations differ from miliary tubercles in not containing giant cells. The tissue contains giant cells, however, but they are only found far removed from the tubercles, among the cells infiltrating the fibres. Repeated attempts at staining failed to demonstrate tubercle bacilli in the tissues." Seven months afterwards a tumour was detected beneath the external portion of the superior wall of the orbit.

March 2, 1893; this second growth was removed in fragments without enucleating the eye. The lacrymal gland and a part of the external rectus were excised with it. Under the microscope it was found to be a fibro-sarcoma involving the muscle and the lacrymal gland.

This suggests the inference that the growth first removed was also sarcomatous; it is well known that the microscopic diagnosis of sarcoma in an early form is often difficult, and has, before now, been mistaken for tubercle. The groundwork of the second tumour is a dense laminated fibrous tissue. Some parts are almost free from cellular elements, others contain a large number of cells in groups or tracts. The arrangement of the cells is constant and very characteristic. They form sheaths about the blood-

vessels, the long axis of the cell lying mostly parallel to the axis of the blood-vessel. Sections of the growth in which a vessel has been cut longitudinally, show therefore a more or less linear tract of sarcomatous spindle cells; where a vessel has been cut transversely, we get a circular aggregation of the growth substance. About many vessels in the tumour there are leucocytes lying near or among the sarcoma cells. Again in parts of the growth, while some of the transversely cut vessels show, as above mentioned, a surrounding ring of sarcomatous cells, others also cut transversely are encircled by a ring, not of cells but of concentrically laminated fibrous tissue, and there are many instances of sheaths, partly cellular or partly fibrous, varying in different degrees between the two extreme types. In the portions of the tumour hitherto referred to, the inner coats of the vessels are normal, and the new cells have grown by the proliferation of the adventitial cells. But near the lacrymal gland, there are layers of endothelial cells forming the wall of a hollow tube. The cells have an oval nucleus, the long axis radiating from the lumen. The author does not consider it possible to say, from their appearance, whether these cells have arisen from blood-vessels or lymphatics. There are some large vessels near the lacrymal gland in which the lumen is entirely blocked by the proliferation of the endothelium.

Case II.—E. O., aged 7, seen first in May, 1890. There was a history of injury four years before—a cut on the right eyebrow—but nothing more recent. Two months before bringing her, the parents had noticed that the right eye was prominent. Right eye displaced, slightly downward, outward and forward. Mobility not affected. A non-adherent tumour can be felt in the upper and inner portion of the orbit. May 23, tumour removed; it was nearly spherical, about half an inch in diameter, and was lying loose in the cellular tissue of the orbit. Frequent recurrences took place, some of which were freely excised, but the growth continued notwithstanding, until the child died in August, 1891. Microscopic examination proved the tumour to be composed mostly of dense masses of small

sarcoma cells. In some parts are many giant cells. The muscles are much involved and atrophied. In one part the growth has a thick fibrous capsule which is pervaded with capillaries having sarcoma cells about them, and the tissues outside the capsule are infiltrated with sarcoma cells.

Case III. was that of a man, aged 56, whose eye had been excised six weeks before he was seen by Knapp, in Feb., 1892. Section of the globe had shown a melano-sarcoma of the choroid extending down the optic nerve to its cut end. At the time that the patient consulted Knapp, there was some fulness of the orbit and exenteration was performed by him. Three hard nodules were amongst the mass of the orbital contents, one of them being a portion of optic nerve. The nerve fibres were found, under the miscroscope, to be atrophied and the connective tissue septa filled with pigmented or unpigmented sarcoma cells. The pial sheath was free, as also the intervaginal space except where the central vessels pass from the nerve through the dorsal sheath. At this point there is a continuous mass of spindle cells uniting the nerve and dorsal sheath. In the dorsal sheath are numerous small vessels and capillaries with proliferating walls; groups of unpigmented sarcoma cells and of dense leucocyte infiltration are scattered here and there. The fatty tissue investing the dorsal sheath is slightly affected with the sarcomatous growth.

"The fibrous tissue in the substance of a sarcoma, or forming its capsule may have," says the author, "three sources of origin: (1) it may be simply the previously existing tissue of the part, changed in its relations by the development of the sarcoma cells; (2) it may be new tissue formed in the usual way by the proliferation of connective-tissue cells or formative cells, as in ordinary hyperplasia, or in fibroma; (3) it may be developed by the proliferation of the adventitial cells of vessels." In each of his three cases the writer considers that there is evidence, more particularly in the denser portions of the tumours, that the growth has developed in the last of the three ways

mentioned. It is particularly well seen in portions in which fibrous tissue is undergoing sarcomatous infiltration. So far as the conditions found in his three cases may allow of generalisation, the author concludes that orbital sarcoma develops mostly "from the proliferation of the adventitial cells and more rarely of the endothelial cells of vessels, that there may be but a slight proliferation about a vessel for a distance from the main tumour, and then at some point a large focus, and that even dense connective-tissue membranes and capsules offer little resistance to the extension of sarcoma when the vessels of the tumour are continuous with those of the membrane." N. M. ML.

AMERICAN OPHTHALMOLOGICAL SOCIETY.

Twenty-ninth Annual Meeting, Held at New London, 1893.

(*Continued from page* 284.)

Dislocation of the Iris under the Conjunctiva, Sympathetic Ophthalmia.—Dr. H. Knapp, of New York, reported the case of a man, aged 45, whose left eye had been struck by the head of a small pet dog, with which he was playing. The sight was impaired, but the eye not painful. There was some sub-conjunctival hæmorrhage, and two millimetres from the inner corneal margin the conjunctiva was raised by a round black substance one centimetre in diameter, the dislocated iris. The conjunctiva and cornea showed no injury, the lens was in position, transparent, and encircled by the ciliary processes. Some blood was in the lower part of the vitreous, but the fundus was sufficiently clear to make it possible to exclude the presence of neuro-retinitis, or rupture of the choroid. Tension was found normal; vision 15/200. The patient

was kept quiet, with the eye lightly bandaged, without operative interference. The right eye was free from irritation. It had always been the weak eye, vision= 20/70.

Twenty-nine days after the injury he returned with redness of the right eye, some blurring of sight, and no pain. Active treatment was instituted, but sympathetic inflammation developed and ran its course, with relapses, until the pupil was closed by a dense opacity. Vision = 1/200. In the left eye, the vitreous opacity grew denser and extended. The fundus details were no longer discernible. Vision = 2/200.

Dr. J. F. Noyes had seen a case in which one lens and iris were completely, and the other lens and iris were partially, dislocated beneath the conjunctiva by successive blows with the fist.

Magnet-Removal of Steel from the Vitreous.—Dr. E. E. Holt, of Portland, Maine, reported three additional cases, in which pieces of steel had entered through the cornea, passing in one case through the lens and not touching the iris, and in other cases passing through the periphery of the iris, leaving the lens uninjured. An incision for extraction was made in each case through the sclerotic behind the equator of the eye-ball, and in each case the knife came in contact with a foreign body. Still, one of the cases required the introduction of the magnet five times before the foreign body was removed. The injured lens underwent absorption, and in all cases the eye was retained with good vision.

Dr. Edward Jackson thought the favourable result in these cases largely due to two things—the entrance of the foreign body through the cornea, iris, and lens, lessening the risk of infection of the vitreous, and the good fortune of bringing the knife in contact with the steel in the attempt at extraction. Unless there was a clean cut through the vitreous to the foreign body, or the extraction was made through the wound of entrance, the foreign body could rarely or never be dislodged from the vitreous by the magnet.

Permanent Magnet for removing Steel from the Cornea.—Dr. Walter B. Johnson, of Paterson, N.J., presented a magnet made of the highest quality of steel, cylindrical, with cone points, highly tempered and charged by rotating within the magnetic field of a generator. It would retain its strength a long time, and could be re-magnetised in any place where a dynamo was in operation. It served excellently to remove particles of steel which had almost penetrated the cornea and entered the anterior chamber.

Congenital Orbital Cyst with Anophthalmos.—Dr. George C. Harlan reported a case in a well developed child five months old. The left eye and its appendages were in all respects normal. The tumour, the size of a small hen's egg, filled the right orbit and projected beyond it. The orbit was of adult size; the lids bulged forward, were distended to twice their normal dimensions, and their edges separated two centimetres. The skin was movable and natural in appearance. There was no atrophy. The cilia were normal, but widely separated by the stretching of the lid margin. The exposed conjunctiva was congested, but not much changed. There was no discharge. There was nothing to mark the position of the cornea but an almost imperceptible puckering of the conjunctiva. There was no movement of the tumour and no pulsation, and it was incompressible. Fluctuation was distinct, but very tense.

As the tumour was growing and the deformity great, it was decided to remove it. Incision through the conjunctiva gave exit to a quantity of clear watery fluid. The cyst wall was simple, the outer portions being fibrous and tough, and the inner delicate, semi-transparent, and bluish. The child died twenty-two hours after the operation, apparently from exhaustion following the shock. A careful investigation of the orbit after death showed no connection with the cranial cavity and no indication of an optic nerve. Nothing resembling an eye could be found in the extirpated cyst, though at the bottom of the sac there was an undefined mass of tissue about half as large as a hazel-nut, which seemed like a thickening of a cyst

wall at that point. On microscopic examination no anatomical elements could be found, except dense connective tissue and muscle fibres isolated or loosely joined together in fasciculi, which might represent some of the muscles of the eye-ball.

From a review of the literature on the subject, Dr. Harlan concluded that the tumour was probably formed of the embryonic tissue of the eye, being either an exaggerated hydrophthalmos or that it originated as an encysted coloboma, which in this case, by its early inception and enormous growth, had prevented the evolution of the eye.

Squint, Amblyopia, and Recovery of Vision.—Dr. Johnson reported a case of vision improved by use in a previously amblyopic eye. [*See page* 256.]

Dr. S. D. Risley had seen a case which gave the history of convergent squint in the right eye, which was almost blind. Tenotomy was done, and four years later the patient came with the right, the fixing eye, with good vision, and the left converging and with vision 1/10. Tenotomy was again done, and correcting glasses ordered. Three months later vision = 3/4 in the left eye.

In another case in a boy, vision was brought up nearly to the normal by careful exercise of the squinting eye, and then, this being neglected for some months, it fell to 1/3. Tenotomy restored binocular vision, and in two weeks the vision in the previously squinting and amblyopic eye rose to 6/6.

Dr. Randall also reported a case, carefully watched, where vision had diminished as the squint became more fixed, and became normal after the constant use of correcting glasses that cured the squint.

Restoration of Upper Lid by Flap from the Cheek.—Dr. S. B. St. John (Hartford, Conn.), reported two cases in which the upper lid had been destroyed by injury, which were greatly benefited by this operation. In making the flap the incision is commenced half an inch in front of the ear, running forward below the lower lid to the side of the

nose. It is then carried downward until sufficient width is secured, and backward to complete the flap. The flap is secured in place by numerous stitches, and the gap left closed by undermining the tissues of the cheek below the wound, and sliding them up.

Drs. Knapp, Mathewson, Noyes, and Carmalt had used the method, and preferred it to transplantation without pedicle (Wolfe's method) which was liable to be followed by great shrinking, or complete disappearance of the transplanted portions.

Dr. Howe preferred Wolfe's method.

Dr. J. C. Reeve had seen the least shrinkage in a case of transplantation by Wolfe's method, where the lids remained united for a year.

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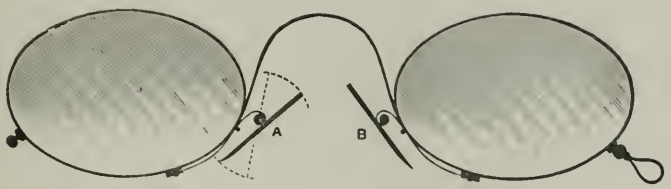

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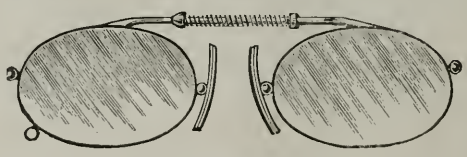

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Patent No. 8953, July, 1885.

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